GenFit2:
Test RKTrackRep

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Outline

Speed Up!

- Discussed with Jin. We decided to use RKTrackRep built in with the current release of GenFit2.
- RKTrackRep is mature and used in many experiments.
- The sPHENIX geometry could be ported to TGeo.
- Can run G4 simulation and RKTrackRep simultaneously.

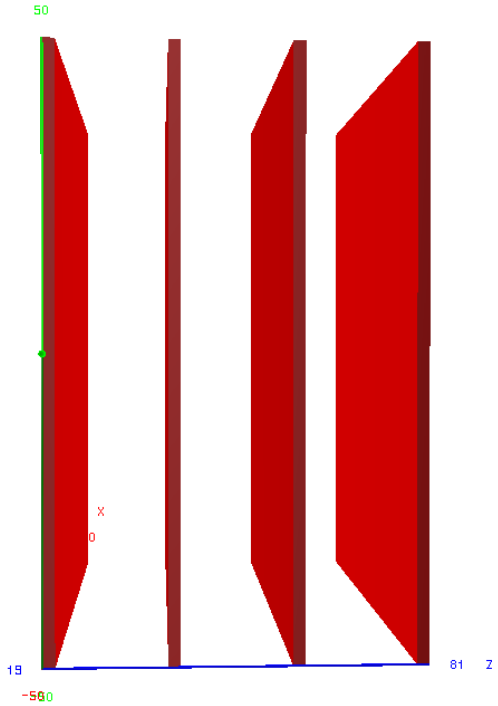
RKTrackRep:

- Developed for PandaRoot, and have been used in several experiments: . Belle II, PANDA, SHiP, AFIS, GEM-TPC, FOPI, ...
- Use TGeometry to describe the detector
- Propagate through magnetic field: Runge-Kutta method
- Material effect (energy loss, multiple scattering, etc.): GenFit's own calculation.

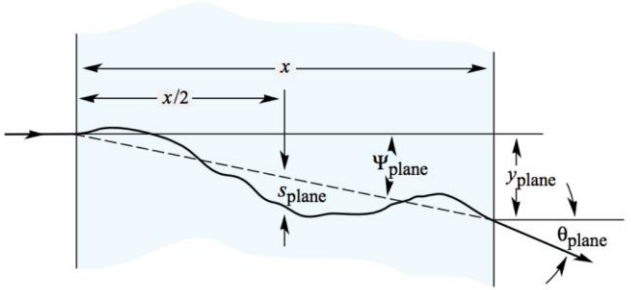
Today's Topic: Test RKTrackRep.

- Material effect
- Propagate through magnetic field
- Fitter test: Pull, residual.

Multiple scattering



4 station Pb
2cm thick each



$$\theta_0 = \frac{13.6\ \text{MeV}}{\beta c p}\, z\, \sqrt{x/X_0}\left[1 + 0.038 \ln(x/X_0)\right]$$

$$y^{\text{rms}}_{\text{plane}} = \frac{1}{\sqrt{3}}\, x\, \theta^{\text{rms}}_{\text{plane}} = \frac{1}{\sqrt{3}}\, x\, \theta_0 \;;$$

2cm Pb, 10 GeV mu+	Calculation	Geant4e
θ0	0.0027	0.0026
y0 / cm	0.0031	0.0030

2cm Pb, 10 GeV mu+	Calculation	RKTrackRep
θ0	0.0027	0.0029
y0 / cm	0.0031	0.0033

2cm Si, 10 GeV mu+	Calculation	RKTrackRep
θ0	0.00059	0.00066
y0 / cm	0.00068	0.00076

Propagate through magnetic field, 2 Tesla, in vacuum

Initial State (0 cm): 10 GeV mu+

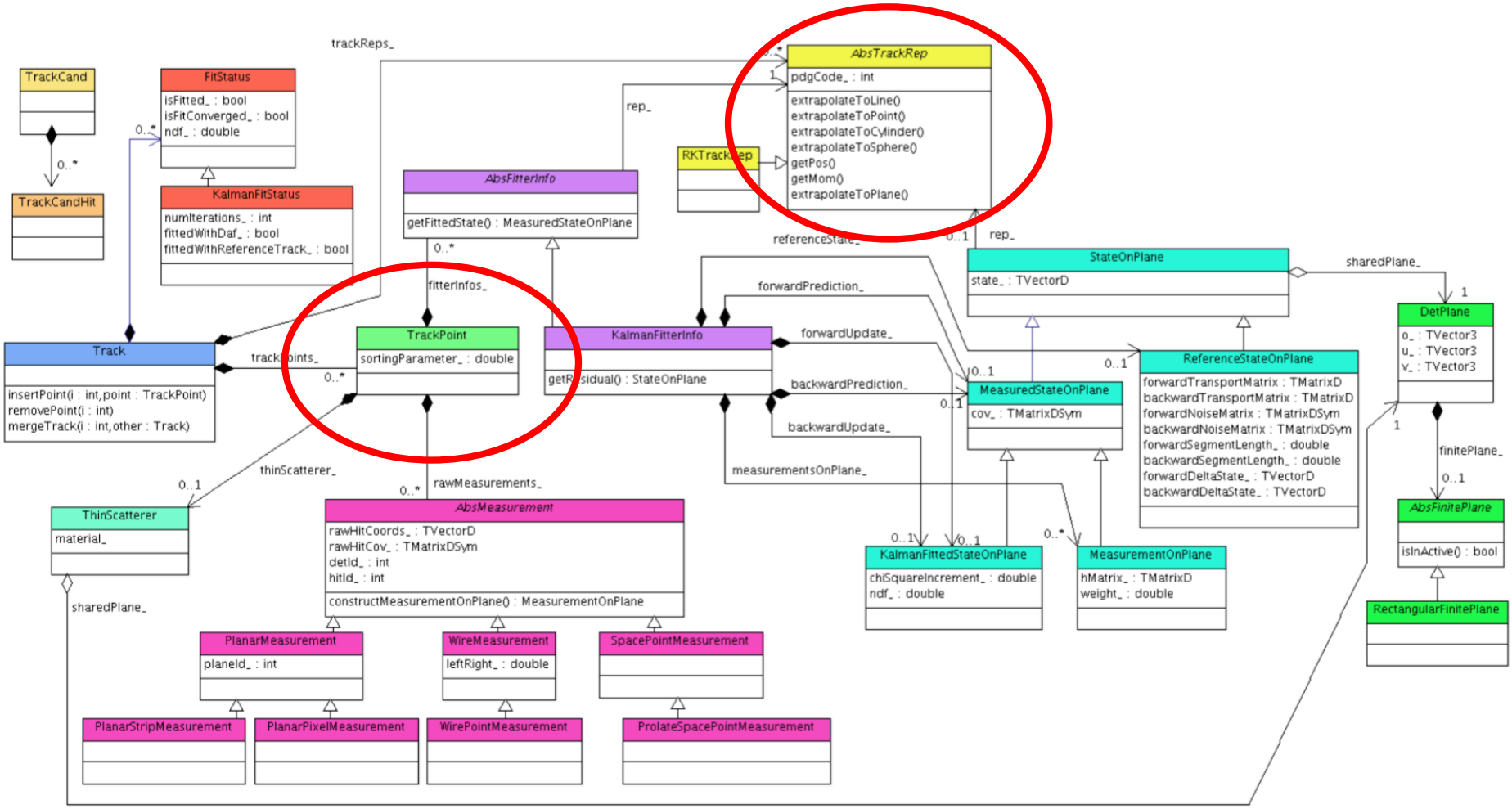
```
3D position: TVector3 A 3D physics vector (x,y,z)=(0.000000,0.000000,0.000000)
3D momentum: TVector3 A 3D physics vector (x,y,z)=(0.000000,0.000000,10.000000)
```

Final State (10 cm)

```
3D position: TVector3 A 3D physics vector (x,y,z)=(0.000000,0.029980,10.000000)
3D momentum: TVector3 A 3D physics vector (x,y,z)=(0.000000,0.059958,9.999820)
```

Calculated py = 0.06 GeV

The data structure of GenFit2, genfit::Track

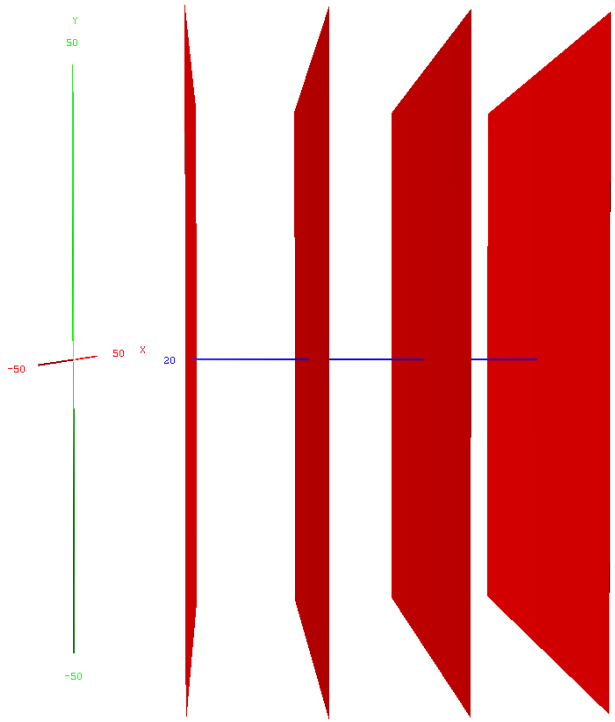


Fitter Test: Procedure

- Setup TGeo detector
- Initialize a μ with pos, mom
- Construct genfit::Track
  - Create measurements:
    - Construct RKTrackRep rep_true with true pos,mom
    - Give an arbitrary detector resolution (0.1cm)
    - Propagate rep_true to detector plane to get hit
    - Smear hit with resolution.
  - Create TrackRep: rep_fit
    - Smear true initial state as seed
- Do the fit.
- Extrapolate rep_fit to plane z = 0. And calculate pull, residual

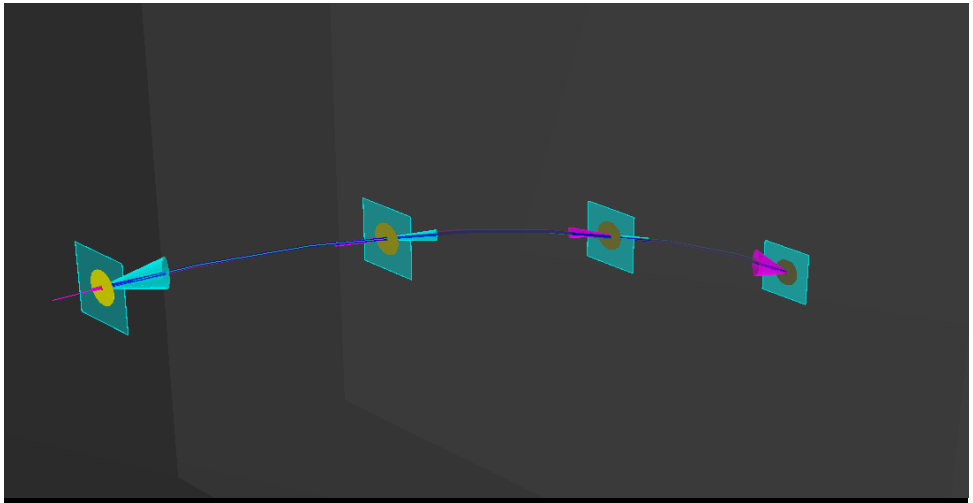
Fitter test: detector setup

z plane detectors, 50μm Si



B: 2T

μ: (0,0,0)cm; (0,0,1)GeV



GenFit Event Display:

Smoothed track: weighted average between forward fit and backward fit

Yellow: measurement uncertainty × 10

Measurement Types

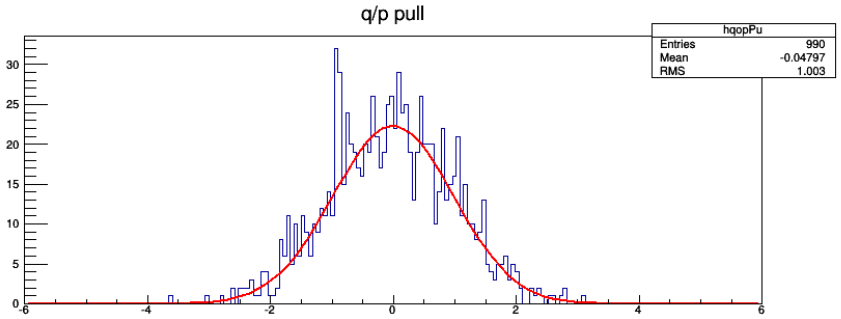
$m_k = H_k\tilde{x}_k + v_k$	Hit coordinates vector (can be one-dimensional). Hits are counted with the index k.
$\tilde{x}_k$	The (unknown) *true* state vector.
H_k	Linear transformation from the vector space of state vectors to the vector space of detector measurements, i.e. m_k and $H_k \cdot \tilde{x}_k$ are in the same coordinate system. The matrix has the dimension $\dim(m_k) \times \dim(\tilde{x}_k)$.
v_k	Deviation or noise of the position measurement.

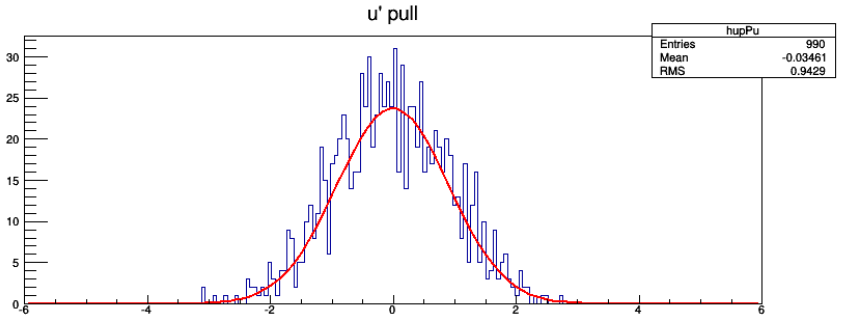
Measurement Type:

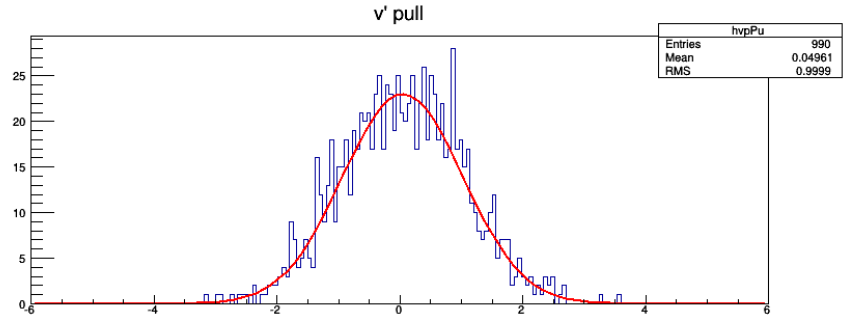
Space Point: TPC
Planar: Silicon
Wire: Drift Chamber

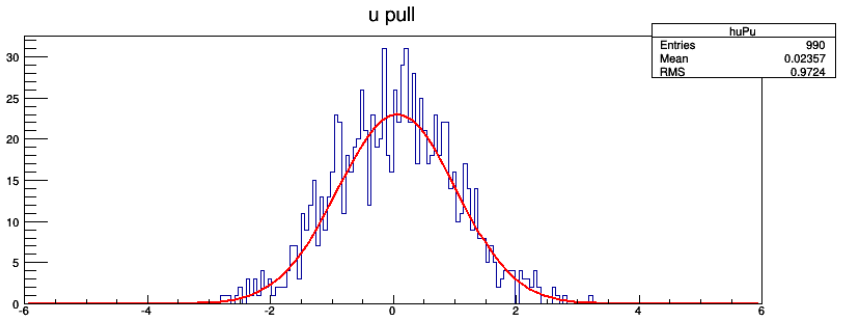
```
const TMatrixD& HMatrixUV::getMatrix() const {
  static const double HMatrixContent[2*5] = {0, 0, 0, 1, 0,
                                             0, 0, 0, 0, 1};
```

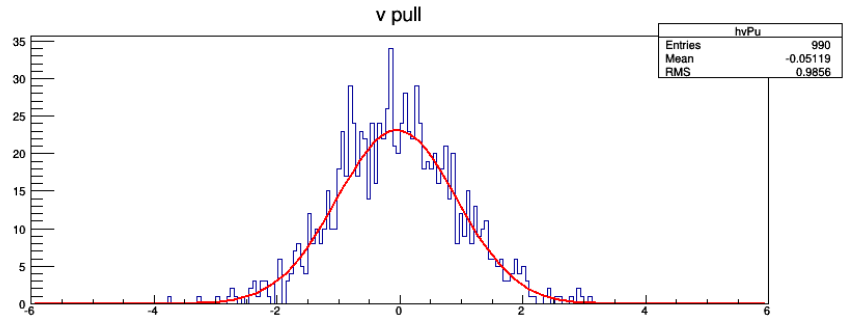
Pull distribution



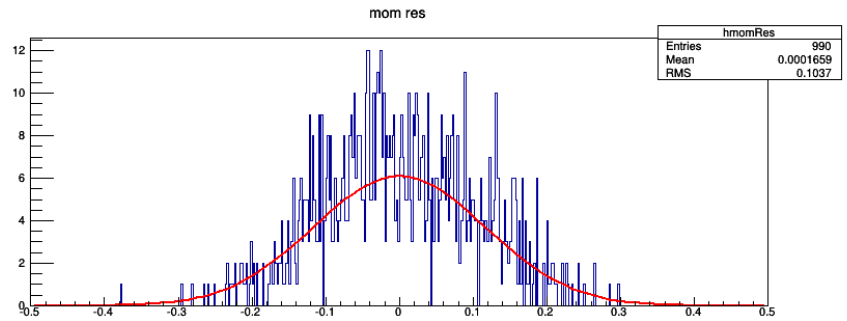


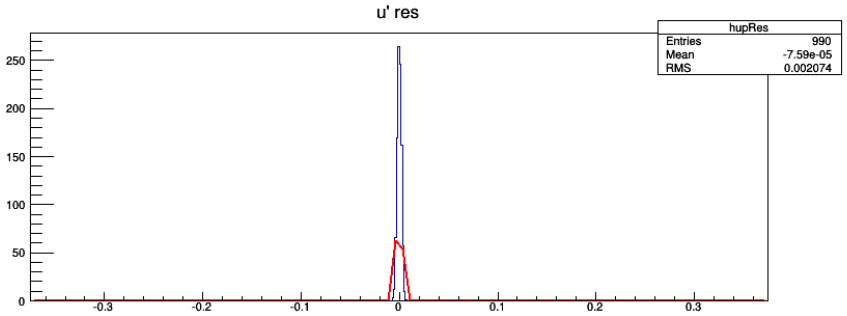


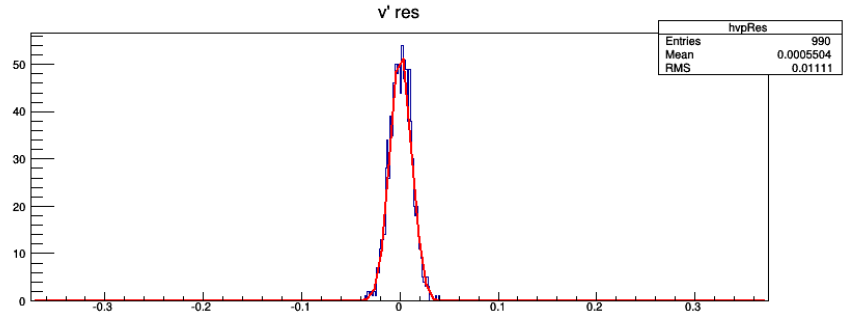


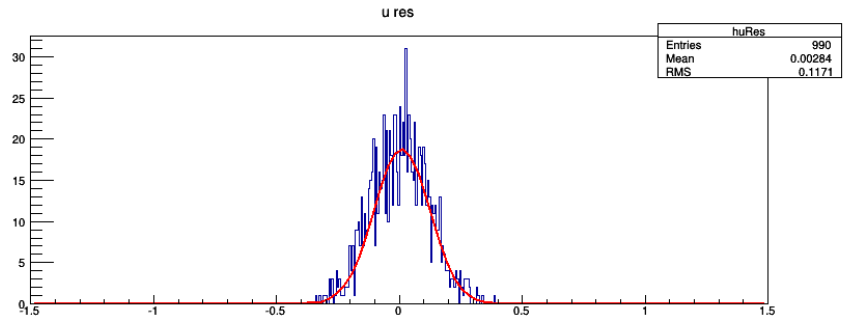


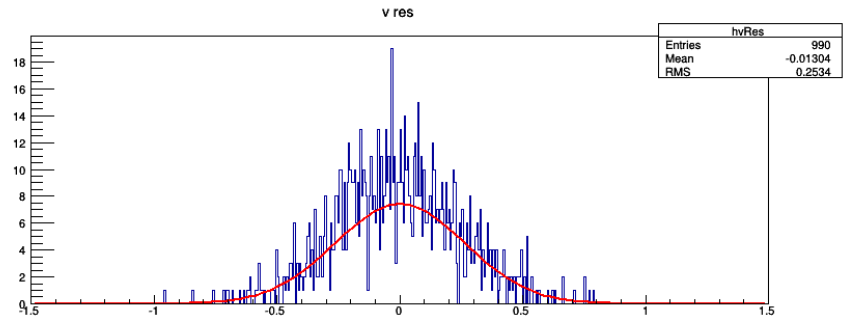
Residual


mom res
hmomRes
Entries 990
Mean 0.0001659
RMS 0.1037


u' res
hupRes
Entries 990
Mean -7.59e-05
RMS 0.002074


v' res
hvpRes
Entries 990
Mean 0.0005504
RMS 0.01111


u res
huRes
Entries 990
Mean 0.00284
RMS 0.1171


v res
hvRes
Entries 990
Mean -0.01304
RMS 0.2534

Summary

- Switched to RKTrackRep for now for speed and robustness.
- Leaning and testing GenFit2 with RKTrackRep
  - Material effect
  - Fitter statistical test

- Next step:
  - Real-world test with simplified sPHENIX detector.

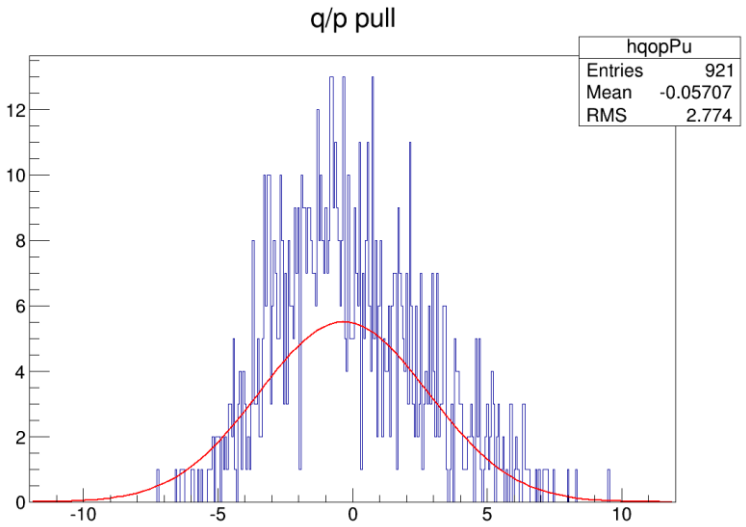
Backups

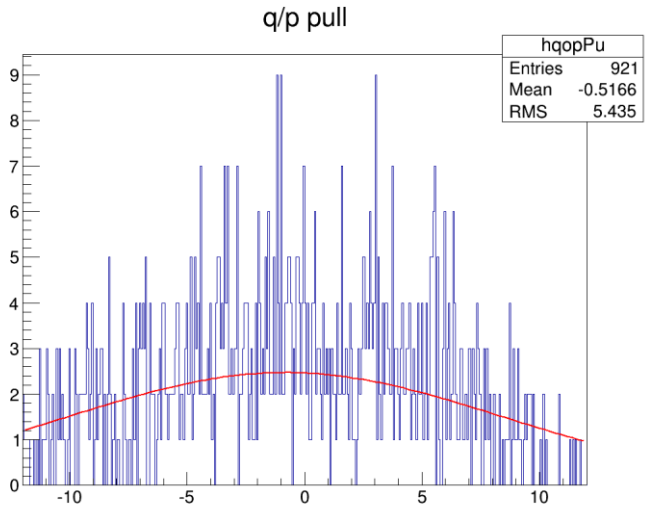

Y
-20
-20

Outline

- Discussed with Jin. And we decided to use RKTrackRep built in with the current release of GenFit2.
  - RKTrackRep is mature and used in many experiments.
  - The sPHENIX geometry could be ported to TGeo.
- Test RKTrackRep

- trackReps
  - include
    - AbsMaterialInterface.h
    - DetectorConstruction.h
    - G4eTrackRep.h
    - G4GFConv.h
    - MagField.h
    - MaterialEffects.h
    - RKTools.h
    - RKTrackRep.h
    - StepLimits.h
    - TGeoMaterialInterface.h
  - src
    - DetectorConstruction.cxx
    - G4eTrackRep.cc
    - G4GFConv.cxx
    - genfitG4eLinkDef.h
    - MagField.cxx
    - MaterialEffects.cc
    - RKTools.cc
    - RKTrackRep.cc
    - StepLimits.cc
    - TGeoMaterialInterface.cc
    - trackRepsLinkDef.h


q/p pull
hqopPu
Entries 921
Mean -0.05707
RMS 2.774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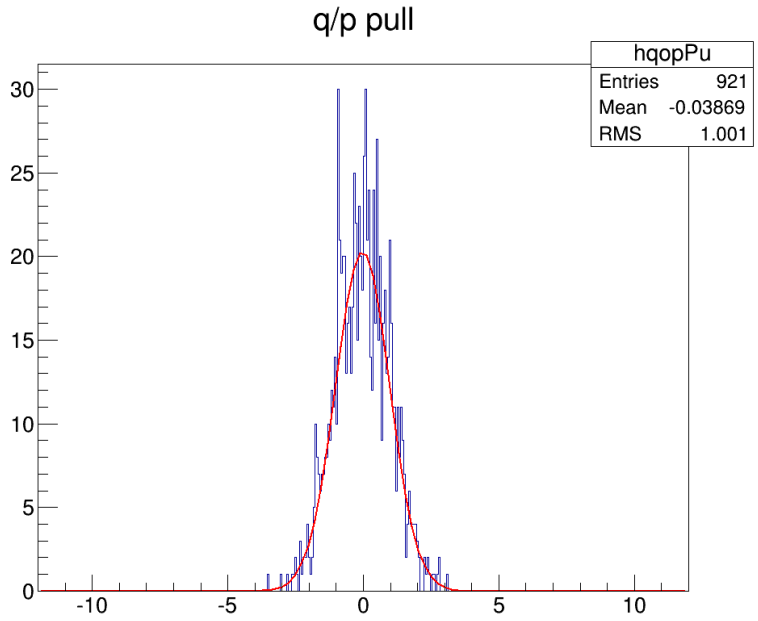
hqopPu
Entries 921
Mean -0.5166
RMS 5.435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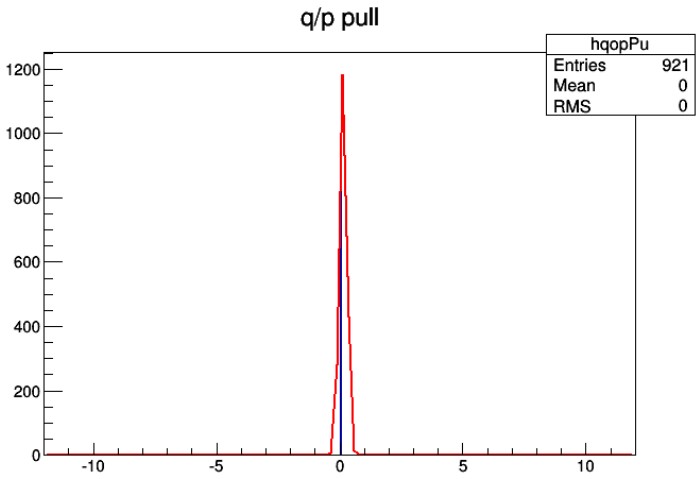
hqopPu
Entries 921
Mean -0.03869
RMS 1.001


q/p pull
hqopPu
Entries 921
Mean 0
RMS 0